

# **Medicinal Plants in the Diet of Golden Langur *Trachypithecus geei* in Kakoijana Reserve Forest, Western Assam, India. A Bio-Rational for the Search of New Medicines for Human Use?**

**Roy D\* and Nagarajan R**

Department of Zoology and Wildlife Biology, India

**\*Corresponding author:** Debahutee Roy, Department of Zoology and Wildlife Biology, A.V.C. College (Autonomous), India, Tel: 9073017319; Email: moni.roy8@gmail.com

**Research Article**

Volume 2 Issue 2

**Received Date:** February 01, 2019

**Published Date:** March 04, 2019

**DOI:** 10.23880/izab-16000137

## **Abstract**

The present study expected to compare the plant food diet of Golden Langur (*Trachypithecus geei*) inhabiting in Kakoijana Reserve Forest of Western Assam with medicinal plant species used by humans in the surrounding areas of the park as vegetables with medicinal properties. The diet of Golden Langur was studied by direct observation and Scan sampling method along with the plants used as medicine and food by the local tribes, India from March 2013 to April 2015. A group of 9 Golden Langurs of different age and sex classes was observed to feed on 152 different plant species belonging to 55 families. Among the different plant categories, trees accounts for 76%, followed by climber and shrub each 10%, grass 2%, fern and orchid each being 1% and liana 0.7%. The highest percent of food tree species belonged to the family Moraceae (9%) followed by Fabaceae (7%) and Euphorbiaceae (5%). The Langurs primarily fed on young leaves, mature leaves, fruits, seeds, figs, tubers and flowers during the study period. Semi structured interviews showed that 45 plant species used by locals as medicines, 17 species used as vegetables and two are rare medicinal plants of Assam. The diet species of Golden Langur was compared with other areas and discussed. The similarities between the ingestion of plants by primates and their medicinal use by humans provide a bio-rational for the search of bioactive plants in primate diet.

**Keywords:** Golden Langur; Food Plants; Overlap Medicinal Plants; Kakoijana Reserve Forest

## **Introduction**

Food and shelter are the vital needs of all living organisms. The appraisal of feeding habits of an animal is of the outmost significance for the correct determination of the carrying capacity of their habitat and for the study

of their population dynamics [1,2]. To endure and reproduce successfully every animal needs food. The food habit of a species is one of the most basic aspects of its ecology and needs to be understood not only to determine the species' nutritional requirements, but also to understand how distribution of food resources could

determine the density, local distribution and social interactions [3]. It has been shown that many different primates species ingest plants containing both nutritional and medicinal value, suggesting that these secondary metabolites could actually be beneficial to the health of the user [4-6] Food habit studies helps to assess the dietary overlap with other sympatric species. Most primates have a diverse plant based diet, from which they obtain the needed calories and nutrients necessary for survival and reproduction [7,8] Plants provide more than just nutrients. The major plant dietary strategies are frugivory and folivory, supplementing this with seeds, sap, bark and flowers [8]. Plants also contain a variety of secondary metabolites that have largely been viewed as deterring primates from eat them [9]. It allows us to assess the impacts of anthropogenic pressures like fire and cattle grazing, also natural and manmade changes in the structure and composition of vegetation [2].

Golden Langur Khajuria, 1956 is one of the least studied primate species of North- east India. The Golden Langur *Trachypithecus geei* is a rare colobine monkey with a very restricted range being confined to western Assam in India, and Bhutan only. Within India, its entire population is restricted to parts of western Assam where it is bounded by the rivers, Brahmaputra in the south and its tributaries, the Manas and the Sankosh towards east and west respectively [10]. The golden Langur is classified as Endangered (EN) [A2c; C2a (i)] on the IUCN Red List 2008 and is listed on Appendix I of CITES. Listed as Endangered because of a serious population decline, estimated to be more than 50% over the last three generations (thirty years), inferred from observed reduction in the extent of its habitat; and because its population size is estimated to number fewer than 2,500 mature individuals, there is an observed continuing decline in the number of mature individuals, and no subpopulation contains more than 250 mature individuals. The Golden Langur population has recovered significantly at Kakoijana Reserve forest recently, after the Golden Langur Conservation Project (GLCP) begun by Community Conservation, Nature's Foster and Green Forest Conservation in 1998 continues to bring locals into the conservation fold.

The study of diet can help to understand the role of a species in the energy flow and nutrient cycle of an ecosystem. It also sets a foundation for understanding of foraging behaviour, population dynamics, habitat use and social organization of a species [11]. Knowledge on feeding preferences and nutritive requirements is essential in planning habitat management. Overlap in the

plant food/medicinal use with the plant food of Golden Langur can suggest a new side for the search of bioactive plants in the diet of primates. Further detailed investigation of their pharmacological value is considered necessary. It would be advantageous to have information on the habitat requirements of a species in order to protect and improve these attributes. The present study aims to provide such information for Golden Langur and also aims at increasing our knowledge of the species.

### Study Area



Figure 1: Google map of Kakoijana Reserve Forest.

Kakoijana Reserve Forest (KRF) is located in Bongaigaon district of western Assam between 26° 24' N-latitude and 90° 36.5' E longitude with a total area of 17.201 square kms. The region has a tropical monsoon climate receiving an annual average rainfall of about 100 cm with max and min temperature of 36 c and 10 c respectively. Altitudinal variation of KRF ranges between 35 meter and 60 meter above sea level. KRF is bounded on East by the river Aie and on west by river Kujia with its tributaries. Remaining sides of KRF possess paddy fields.

- **Flora :** *Shorea robusta*, *Dillenia sp.*, *Ficus sp.*, *Albezia sp.*, *Terminalia sp.*, etc
- **Fauna:** Binturong, Jungle Fowl, Porcupine, Python, Civets, Barking Deer, Monitor Lizard, Jungle Cat etc.
- **Primate community:** Golden Langur (*Trachypithecus geei*) and Rhesus Macaque (*Macaca radiata*)



Figure 2: Landscape showing the habitat of Golden Langur in Kakoijana Reserve Forest of Assam, a fragmented habitat with adjacent paddy fields.

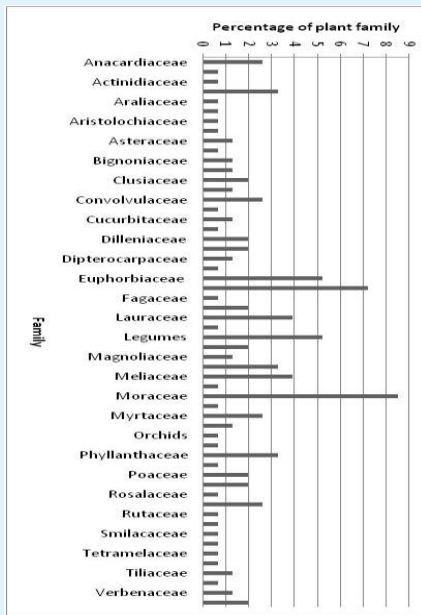


Figure 3: Percent composition of different food plants of Golden Langur belonging to different families in Kakoijana reserve forest during the study period (Families of different plants arranged based on ranking).

Percentage of different plant categories in the diet of Golden Langur

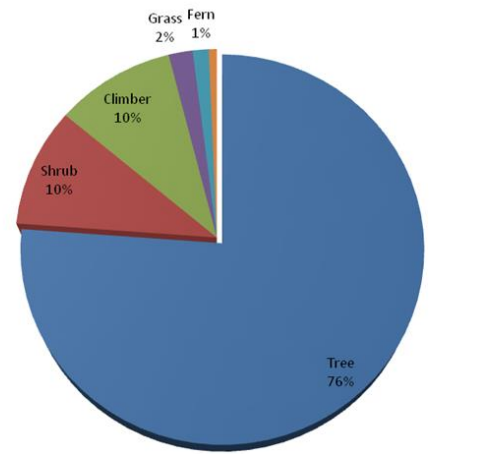


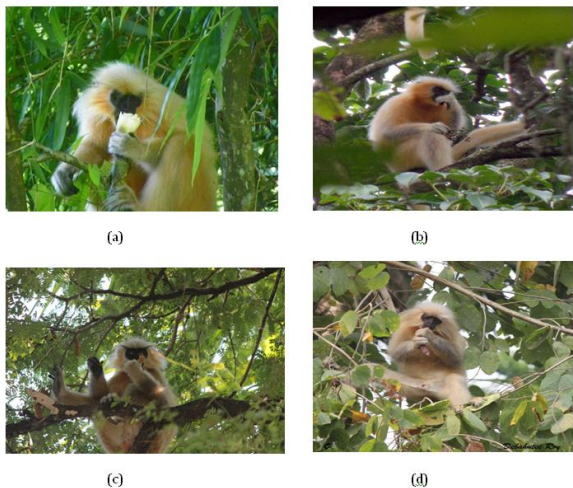
Figure 5: Proportion of different plant categories constitutes food species of Golden Langur in Kakoijana Reserve Forest during the study period (March 2013-April 2015).

## Materials and Methods

Information on the food plants was collected through direct observation and indirectly by recording plants fed on by Langur by following their feeding trail. The study was conducted in Kakoijana Reserve Forest from March 2013 to April 2015. Feeding by individuals was observed using scan animal sampling [1] during different time blocks throughout the day (Figure 5). Binoculars were used to make all direct observations. The feeding trails were examined for fresh feeding signs after Langur left the location as Langurs have the habit of discarding half of leaf or fruit they consume. Fresh feeding signs could be easily distinguished from old signs by examining the tip of the branches/twigs and fruits with bite signs. A herbarium of the food plants was made for confirmation of the species identity. Semi structured interviews, field diary and participant observation were used during fieldwork Bernard, et al. were conducted among the different tribes around the forest areas to know the usage of plant species regarding the medicinal use of the plants included in the diet of Golden Langur.

## Results

Golden Langurs are diurnal, mostly arboreal and partly terrestrial. Golden Langurs are generally



(a): 9 Golden Langur feeding on bamboo shoot  
 (b): Golden Langur feeding on fruits of *Bischoffia javanica*  
 (c): Golden Langur feeding on fruits of *Tamrindus indica*  
 (d): Golden Langur feeding on seeds of *Bauhinia purpurea*

**Figure 4:** Golden Langur feeding on plant parts that are also used by humans in the study area.

foliovorous and young leaves are major component in its diet followed by mature leaves, fruits, shoot, seeds, figs and flowers. Golden Langurs are selective feeders and feed on variety of food plants throughout its life time. During the study period, it was observed that Golden Langur consumed different plant species from various physiognomic categories. The list of food plants, parts eaten (based on scan sampling) are given in the (Table 1). During the study period it was observed that Golden

Langur consumed different plant species belongs to 55 families and 152 species. *Terminalia belerica*, *Lagerstroemia parviflora*, fruits of *Syzygium cumni*, young leaves of *Cassia fistula*, leaf petiole of *Shorea robusta*, *Tectona grandis*, *Delonix regia*, *Hevea brasiliensis*, *Moringa oleifera*, *Gmelina arborea*, *Syzygium sp*, *Dillenia indica*, *Mallotus philippinensis*, *Biscofia javanica*, and *Bauhinia varieagata* were mainly eaten.

Sl.no.	Plant Species	Category	Order	Family	Parts Eaten
1	<i>Acacia auriculiformis</i>	Tree	Fabales	Fabaceae	YL,ML,FL
2	<i>Acacia pinnata</i>	Tree	Fabales	Fabaceae	YL,ML,FL
3	<i>Adina cordiflora</i>	Tree	Gentianales	Rubiaceae	YL,ML
4	<i>Aegle marmelos</i>	Tree	Sapindales	Rutaceae	YL,ML
5	<i>Aglaia elaeagnoidea</i>	Tree	Sapindales	Meliaceae	YL,ML
6	<i>Alangium chinensis</i>	Tree	Cornales	Cornaceae	YL,ML,RFR
7	<i>Albizia lebbeck</i>	Tree	Fabales	Fabaceae	YL,ML
8	<i>Alstonia scholaris</i>	Tree	Gentianales	Apocynaceae	YL,ML
9	<i>Amoora Cucullata</i>	Tree	Sapindales	Meliaceae	YL
10	<i>Anthocephalus cadamba</i>	Tree	Gentianales	Rubiaceae	YL
11	<i>Anthocephalus chinensis</i>	Tree	Gentianales	Rubiaceae	YL,ML
12	<i>Antidesm acidum</i>	Shrub	Malpighiales	Phyllanthaceae	RFR
13	<i>Argyrea nervosa</i>	Tree	Solanales	Convolvulaceae	YL,ML
14	<i>Aristolochia sp.</i>	Liana	Magnolids	Aristolochiaceae	YL
15	<i>Artocarpus chaplasha</i>	Tree	Rosales	Moraceae	YL,ML
16	<i>Artocarpus heterophyllus</i>	Tree	Rosales	Moraceae	YL,ML
17	<i>Asplenium nidus</i>	Fern	Polypodiales	Aspleniaceae	YL
18	<i>Averrhoa carambola</i>	Tree	Geraniales	Oxalidaceae	YL,ML
19	<i>Azadiracta indica</i>	Tree	Sapindales	Meliaceae	YL,ML
20	<i>Bambusa sp</i>	Grass	Poales	Poaceae	YL,ML
21	<i>Bambusa tulda</i>	Grass	Poales	Poaceae	YL,ML
22	<i>Bauhinia bhelli</i>	Tree	Fabales	Fabaceae	YL,ML
23	<i>Bauhinia purpurea</i>	Tree	Fabales	Fabaceae	YL,ML
24	<i>Bischofia javanica</i>	Tree	Malpighiales	Phyllanthaceae	YL
25	<i>Bridelia Montana</i>	Tree	Malpighiales	Phyllanthaceae	YL
26	<i>Bursera serrata</i>	Tree	Sapindales	Burseraceae	YL,ML
27	<i>Butea monosperma</i>	Tree	Fabales	Legumes	YL,ML
28	<i>Callicarpa macrophylla</i>	Tree	Lamiales	Lamiaceae	YL,ML
29	<i>Careya arborea</i>	Tree	Ericales	Lecythidaceae	YL,ML
30	<i>Cassia fistula</i>	Tree	Fabales	Fabaceae	YL,ML,FL
31	<i>Castanopsis purpurella</i>	Tree	Fagales	Fagaceae	YL,ML
32	<i>Cedrela toona</i>	Tree	Sapindales	Meliaceae	YL,ML
33	<i>Cinnamomum sp.</i>	Tree	Lurales	Lauraceae	YL
34	<i>Cinnamomum tamala</i>	Tree	Lurales	Lauraceae	YL
35	<i>Cissampelos pareira</i>	Climber	Ranunculales	Menispermaceae	YL,ML
36	<i>Cissus quadrangularis</i>	Shrub	Vitales	Vitaceae	YL,ML
37	<i>Cissus rependus</i>	Shrub	Vitales	Vitaceae	YL,ML
38	<i>Dalbergia latifolia</i>	Tree	Fabales	Legumes	YL,ML
39	<i>Dalbergia paniculata</i>	Tree	Fabales	Legumes	YL,ML

40	<i>Dalbergia sissoo</i>	Tree	Fabales	Legumes	YL,ML
41	<i>Delonix regia</i>	Tree	fabales	Fabaceae	YL,ML,FL
42	<i>Dendrobium sp.</i>	Orchid	Asparagales	Orchids	YL
43	<i>Deris indica</i>	Tree	Fabales	Fabaceae	YL,ML
44	<i>Dillenia indica L</i>	Tree	Dilleniales	Dilleniaceae	YL,ML
45	<i>Dillenia pentagyna</i>	Tree	Dilleniales	Dilleniaceae	YL,ML
46	<i>Dillenia sp</i>	Tree	Dilleniales	Dilleniaceae	YL,ML,FL
47	<i>Dioscorea bulbifera</i>	Climber	Dioscoreales	Dioscoreaceae	TUBER
48	<i>Dioscorea alata</i>	Climber	Dioscoreales	Dioscoreaceae	TUBER
49	<i>Dioscorea floribunda</i>	Climber	Dioscoreales	Dioscoreaceae	TUBER
50	<i>Diplazium esculentum</i>	Fern	Polypodiales	Athyriaceae	YL,ML
51	<i>Dolichos lablab</i>	Climber	Fabales	Legumes	YL,RFR
52	<i>Duabanga grandiflora</i>	Tree	Myrtales	Lythraceae	YL,ML
53	<i>Dysoxylum bincetariferum</i>	Climber	Sapindales	Meliaceae	YL,RFR
54	<i>Dysoxylum gobara</i>	Climber	Sapindales	Meliaceae	YL,RFR
55	<i>Elaeocarpus serratus L.</i>	Tree	Oxalidales	Elaeocarpaceae	YL,ML,RFR
56	<i>Emblca officinalis</i>	Tree	Malpighiales	Phyllanthaceae	YL,RFR
57	<i>Endospermum chinense</i>	Tree	Malpighiales	Euphorbiaceae	YL,ML
58	<i>Erythrina sp</i>	Tree	Fabales	Legumes	YL,ML
59	<i>Erythrina variegata L</i>	Shrub	Fabales	Legumes	YL,ML
60	<i>Eupatorium odoratum</i>	Shrub	Asterales	Daisy	YL,ML
61	<i>Evolvus alsinoides</i>	Shrub	Solanales	Convolvulaceae	YL,ML
62	<i>Ficus auriculata</i>	Tree	Rosales	Moraceae	YL,FIG
63	<i>Ficus bengalensis</i>	Tree	Rosales	Moraceae	YL,FIG
64	<i>Ficus drupacea</i>	Tree	Rosales	Moraceae	YL,FIG
65	<i>Ficus glomerata</i>	Tree	Rosales	Moraceae	YL,FIG
66	<i>Ficus heterophylla</i>	Tree	Rosales	Moraceae	YL,FIG
67	<i>Ficus hirta</i>	Tree	Rosales	Moraceae	YL,FIG
68	<i>Ficus hispida</i>	Tree	Rosales	Moraceae	YL,FIG
69	<i>Ficus lepidosa</i>	Tree	Rosales	Moraceae	FIG
70	<i>Ficus racemosa</i>	Tree	Rosales	Moraceae	YL,ML,FIG
71	<i>Ficus sp</i>	Tree	Rosales	Moraceae	YL,FIG
72	<i>Flacourtia jangomas</i>	Tree	Malpighiales	Salicaceae	YL,ML
73	<i>Flueggea leucopyrus</i>	Shrub	Malpighiales	Phyllanthaceae	YL,ML
74	<i>Garcinia cowa</i>	Tree	Malpighiales	Clusiaceae	YL,ML
75	<i>Garcinia xanthochymus</i>	Tree	Malpighiales	Clusiaceae	YL,ML
76	<i>Garuga pinnata</i>	Tree	Sapindales	Burseraceae	YL,ML
77	<i>Gmelina arborea</i>	Tree	Lamiales	Verbenaceae	YL,ML,FL
78	<i>Grewia multiflora</i>	Tree	Malvales	Tiliaceae	YL,ML
79	<i>Grewia sp</i>	Tree	Malvales	Tiliaceae	YL,ML
80	<i>Hemidesmus indicus</i>	Shrub	Gentianales	Apocynaceae	YL,ML
81	<i>Hevea brasiliensis</i>	Tree	Malpighiales	Euphorbiaceae	YL,LP,RFR,SEED
82	<i>Hibiscus macrophyllus</i>	Tree	Malvales	Malvaceae	YL,ML
83	<i>Holmskiodia sp</i>	Tree	Lamiales	Lamiaceae	YL
84	<i>Homonoia riparia</i>	Tree	Malpighiales	Euphorbiaceae	YL,ML
85	<i>Hoya sp.</i>	Tree	Gentianales	Apocynaceae	YL
86	<i>Ipomea sp</i>	Shrub	Solanales	Convolvulaceae	YL
87	<i>Jasminum officinale</i>	Tree	Lamiales	Oleaceae	YL,ML,FL
88	<i>Kydia calicina</i>	Tree	Malvales	Malvaceae	YL,ML
89	<i>Lagerstroemia parviflora</i>	Tree	Myrtales	Lythraceae	YL,ML

90	<i>Lagerstroemia speciosa</i>	Tree	Myrtales	Lythraceae	YL,ML
91	<i>Lannea coromandelica</i>	Tree	Sapindales	Anacardiaceae	YL,ML
92	<i>Lantana camara</i>	Shrub	Lamiales	Verbenaceae	YL,FL
93	<i>Litsaea sebifera</i>	Tree	Lurales	Lauraceae	YL,ML,RFR
94	<i>Litsea laeta</i>	Tree	Lurales	Lauraceae	YL,ML
95	<i>Litsea monopetala</i>	Tree	Lurales	Lauraceae	YL,ML,RFR
96	<i>Litsea salicifolia</i>	Tree	Lurales	Lauraceae	YL,ML
97	<i>Macaranga denticulata</i>	Tree	Malpighiales	Euphorbiaceae	YL,ML
98	<i>Mallotus philippinensis</i>	Tree	Euphorbiales	Euphorbiaceae	YL,ML
99	<i>Mangifera indica</i>	Tree	Sapindales	Anacardiaceae	YL,RFR
100	<i>Mangifera sylvatica</i>	Tree	Sapindales	Anacardiaceae	YL,RFR
101	<i>Merremia sp</i>	Tree	Solanales	Convolvulaceae	YL,ML
102	<i>Mesua ferrea</i>	Tree	Malpighiales	Clusiaceae	YL,ML
103	<i>Michelia champaca</i>	Tree	Magnoliales	Magnoliaceae	YL,ML,FL
104	<i>Michelia oblonga</i>	Tree	Magnoliales	Magnoliaceae	YL,ML
105	<i>Microcos paniculata</i>	Tree	Malvales	Malvaceae	YL,ML
106	<i>Mikania micrantha</i>	Shrub	Asterales	Asteraceae	YL,ML
107	<i>Mikania sp</i>	Shrub	Asterales	Asteraceae	YL,ML
108	<i>Mimosa pudica</i>	Shrub	Fabales	Fabaceae	YL,ML
109	<i>Moringa oleifera</i>	Tree	Brassicales	Moringaceae	YL,FL,UNRF,RFR
110	<i>Nyctanthes arbor-tristis</i>	Tree	Lamiales	Oleaceae	YL,ML
111	<i>Oroxylum indicum</i>	Tree	Lamiales	Bignoniaceae	YL,FL
112	<i>Paederia foetida</i>	Climber	Gentianales	Rubiaceae	YL,ML
113	<i>Piper sp</i>	Climber	Piperales	Piperaceae	YL
114	<i>Psidium guajava</i>	Tree	Myrtales	Myrtaceae	YL,ML,RFR
115	<i>Pterospermum acerifolium</i>	Tree	Malvales	Sterculiaceae	YL,ML
116	<i>Rauvolfia serpentina</i>	Tree	Gentianales	Apocynaceae	YL,ML
117	<i>Rubus sp</i>	Tree	Rosales	Rosaceae	YL,ML
118	<i>Salmalia sp</i>	Tree	Malvales	Malvaceae	YL,ML
119	<i>Sapium baccatum</i>	Tree	Malpighiales	Euphorbiaceae	YL,ML
120	<i>Sapium sp</i>	Tree	Malpighiales	Euphorbiaceae	YL,ML
121	<i>saurauia roxburghii</i>	Tree	Actinidiales	Actinidiaceae	YL,ML
122	<i>Schefflera arboricola</i>	Tree	Apiales	Araliaceae	YL,ML
123	<i>Schima wallichii</i>	Tree	Ericales	Theaceae	YL,ML
124	<i>Shorea robusta</i>	Tree	Malvales	Dipterocarpaceae	YL,ML
125	<i>Smilax sp.</i>	Shrub	Liliales	Smilacaceae	YL,ML
126	<i>Spondias pinnata</i>	Tree	Sapindales	Anacardiaceae	YL,ML
127	<i>Stercula villosa</i>	Tree	Malvales	Malvaceae	YL,ML
128	<i>Sterospermum chelonoides</i>	Tree	Lamiales	Bignoniaceae	YL,ML
129	<i>Streblus asper</i>	Tree	Rosales	Moraceae	YL,ML
130	<i>Syzygium cumni</i>	Tree	Myrtales	Myrtaceae	YL,ML,RFR,FL
131	<i>Syzygium jambos</i>	Tree	Myrtales	Myrtaceae	YL,ML,RFR
132	<i>Syzygium kurjii</i>	Tree	Myrtales	Myrtaceae	YL,ML,RFR
133	<i>Tamarindus indica</i>	Tree	Fabales	Legumes	YL,RFR
134	<i>Tectona grandis</i>	Tree	Lamiales	Lamiaceae	YL,LP
135	<i>Terminalia bellerica</i>	Tree	Myrtales	Combretaceae	YL,RFR
136	<i>Terminalia chebula</i>	Tree	Myrtales	Combretaceae	YL,RFR
137	<i>Tetrameles nudiflora R</i>	Tree	Cucurbitales	Tetramelaceae	YL,ML
138	<i>Thunbergia alata</i>	Tree	Lamiales	Acanthaceae	YL,ML
139	<i>Trema orientalis</i>	Tree	Rosales	Ulmaceae	YL,ML

140	<i>Trichosanthes tricuspidata</i>	Climber	Cucurbitales	Cucurbitaceae	YL,ML
141	<i>Tricosanthes anguina</i>	Climber	Cucurbitales	Cucurbitaceae	YL,ML
142	<i>Triwia nudiflora</i>	Tree	Malpighiales	Euphorbiaceae	YL,ML
143	<i>Vatica lanceifolia (critically en sp.)</i>	Climber	Malvales	Dipterocarpaceae	YL,ML,RFR
144	<i>Vigna catjang</i>	Climber	Fabales	Fabaceae	YL,RFR
145	<i>Vigna Sp</i>	Climber	Fabales	Fabaceae	YL
146	<i>Vitis latifolia</i>	Climber	Vitales	Vitaceae	YL,ML
147	<i>Wrightia tomentosa</i>	Tree	Gentianales	Apocynaceae	YL
148	<i>Zanthoxylum rhetsa</i>	Tree	Sapindales	Rutaceae	YL
149	<i>Zea mays</i>	Grass	Poales	Poaceae	YL,RFR
150	<i>Zizyphus jujuba</i>	Tree	Rosales	Rhamnaceae	YL, RFR,UNRF
151	<i>Zizyphus mauritiana</i>	Tree	Rosales	Rhamnaceae	YL, RFR,UNRF
152	<i>Zizyphus oenoplia</i>	Shrub	Rosales	Rhamnaceae	YL, RFR,UNRF

(YL-young leaf; ML-mature leaf; RFR- ripened fruit; UNRF; unripened fruit; FL-flower)

Table 1: List of food plants of Golden Langurs identified in Kakoijana Reserve Forest of Assam, India. The list is prepared based on alphabetical order of plant species. (a-Classification is based on Bentham and Hooker (1962-63), Sasidharan (2004).

Among the different plant categories, trees accounts for 76%, followed by climber and shrub 10% each, grass 2%, fern and orchid 1% each and liana 0.7% (Figures 1 & 2). Thus trees, climber and shrub were constituted 96% of overall composition of food plant species. The highest percent of food tree species belonged to the family

Moraceae followed by Fabaceae and Euphorbiaceae (Figures 3 & 4). Of these 152 plant species, 45 plant species were used by the local tribes as medicines, 17 were used as vegetables and two species were listed as rare medicinal plants of Assam (Table 2).

Plant Species	Category	Family	Local Medicinal use Recorded in this Study	Use as Vegetables by the Locals	Remarks
<i>Alstonia scholaris</i>	Tree	Apocynaceae	Leaf is used against headache, bark is used to treat stomach trouble	-	-
<i>Antidesm acidum</i>	Shrub	Phyllanthaceae	Leaves are used against headache, and appetizer	Leaves are used as food	-
<i>Argyria nervosa</i>	Tree	Convolvulaceae	Anemia, cold and cough	Leaves are used as food	-
<i>Averrhoa carambola</i>	Tree	Oxalidaceae	Fuit used in jaundice and kidney diseases	-	-
<i>Azadiracta indica</i>	Tree	Meliaceae	Leaf extract is used to cure skin and tooth diseases	-	-
<i>Asplenium nidus</i>	Fern	Aspleniaceae	Infusion of the leaves are used to treat labour pain	Leaves are used as food	-
<i>Bambusa tulda</i>	Climber	Poaceae	Not known	Shoots are used as food	-
<i>Bauhinia purpurea</i>	Tree	Fabaceae	Bark juice is used against menstruation trouble	-	-
<i>Bischoffia javanica</i>	Tree	Phyllanthaceae	Bark is used to treat tuberculosis, mouth	-	-

			ulcers and inflamations		
<i>Butea monosperma</i>	Tree	Legumes	seed, bark and fruit	-	Rare medicinal plant of Assam (Bhattacharya et al., 1991)
<i>Cassia fistula</i>	Tree	Fabaceae	leaf pase is used against allergy	-	
<i>Cinnamomum tamala</i>	Tree	Lauraceae	Barks are used to treat againt diarrhoea	Leaves are used as spice	
<i>Cissampelos pareir</i>	Climber	Menispermaceae	Cures ulcer and sinus problems	-	Rare medicinal plant of Assam (Bhattacharya et al., 1991)
<i>Cissus quadriangularis</i>	Climber	Vitaceae	Stem paste is applied in bone fracture and wound	-	-
<i>Dillenia indica</i>	Tree	Dilleniaceae	Hair washed with mucilage for hair growth	-	-
<i>Dioscorea alata</i>	Climber	Dioscoreaceae	Tubers are used in piles	Tubers are consumed as vegetables	-
<i>Embllica officinalis</i>	Tree	Euphoriaceae	Fruit juice used for indigestion and hair growth	-	-
<i>Erythrina variegata</i>	Shrub	Legumes	Roots helps in comceiving	-	-
<i>Ficus bengalensis</i>	Tree	Moraceae	Bud is used to tread scabies and boils	-	-
<i>Gmelina arborea</i>	Tree	Lamiaceae	Roots and bark are used to cure piles and urinary discharge	Flowers are used as vegetable	-
<i>Plant species</i>	Category	Family	Local medicinal use recorded in this study	Use as vegetables by the locals	Remarks
<i>Grewia multiflora</i>	Tree	Tiliaceae	Bark is used to treat bone fracture	-	-
<i>Ipomoea</i>	Tree	Convolvulaceae	Helps to treat low haemoglobin content in blood	Young leaves and shoots are used as vegetable	-
<i>Lantana camara</i>	Shrub	Verbanaceae	Young leaf extract are used to treat indigestion	-	-
<i>Macaranga denticulata</i>	Tree	Euphoriaceae	Stem juice is useful in skin disease, cuts and wounds	-	-
<i>Mangifera sylvativca</i>	Tree	Anacardiaceae	Stem juice is useful against gastric problems and ucers	-	-
<i>Michelia champaca</i>	Tree	Magnoliaceae	Leaf is used against colic, Seed is used as appetizer.	-	-
<i>Mikenia</i>	Shrub	Asteraceae	leaves and stem are	-	-



<i>macarantha</i>			used to cure diarrhoe and eye trouble		
<i>Mimosa pudica</i>	Shrub	Mimosaceae	Root is use fot treating snake bite	-	-
<i>Moringa oleifera</i>	Tree	Moringaceae	Leaf extraxt is used to treat blood pressure and diabetes	Fruit is used as vegetable	-
<i>Nyctanthes arbortristis</i>	Tree	Oleaceae	Leaf and flower juice used for cough and stomach worm cure		-
<i>Oroxylum indicum</i>	Tree	Bignoniaceae	Seeds are used as digestive	Flowers are used as vegetable	-
<i>Paderia foetida</i>	Climber	Rubiaceae	Leaf juice used to cure constipation	used as vegetable	-
<i>Piper longum</i>	Climber	Piperaceae	leaf extract is used as fever	Fruits are used as spice	-
<i>Psidium guajava</i>	Tree	Myrtaceae	Root and bark used for treating diarrhoea	Fruits are edible	-
<i>Rauvolfia serpentina</i>	Shrub	Apocynaceae	Used to treat high blood pressure and mental illness	-	-
<i>Spondias pinnata</i>	Tree	Anacardiaceae	Unripe fruit along with leaf used to cure gastric ulcer	-	-
<i>Sterculia villosa</i>	Tree	Sterculiaceae	Root extract are used to treat blood dycentry	-	-
<i>Syzygium cumni</i>	Tree	Myrtaceae	Young leaf extract are used to treat diabetes	-	-
<i>Tamarindus indica</i>	Tree	Caesalpinaceae	Fruit extract is used to treat cough and cold	Fruits are used to prepare pickle	-
<i>Terminalia bllerica</i>	Tree	Combretaceae	Fruit used to cure gastric ulcer	-	-
<i>Terminalia chebula</i>	Tree	Combretaceae	Fruit mixed with turmeric used to cure loss of appetite	-	-
<i>Vigna catiang</i>	Climber	Fabaceae	It is a good source of iron and boosts immene system	Leaves are used as vegetable	-
<i>Vitis latifolia</i>	Climber	Vitaceae	Not available	Leaves are used as food	-
<i>Wrightia tomentosa</i>	Tree	Apocynaceae	Bark is used to treat kidney stone		-
<i>Ziziphus jujuba</i>	Tree	Rhamnaceae	Bark juice is useful in stomach trouble	Fruits are used to prepare pickle	-

Table 2: List of food/medicinal plants identified in Kakoijana Reserve Forest of Assam, India.

## Discussion

Golden Langur consumed different plant species throughout the study period identified from May 2013 to

April 2015. It was observed that during flowering and fruiting season, flowers and fruits of certain plants are also consumed along with its young leaf. Flowers and fruits of *Syzygium* sp., *Moringa oleifera*, *Gmelina arborea*,

*Ficus glomerata*, *Tamarindus indica*, *Phyllanthus emblica* and *Spondias pinnata* were mostly preferred.

Das, et al. reported 91 plant species as food species for Golden Langur comprising both trees and climbers in Chirang RF [12]. Mukherjee, et al. reported the names of plants utilized by the Golden Langur for feeding and those data were relevant for summer months [13]. In winter months the most preferred plant items were *Terminalia belerica*, *Lagerstroemia parviflora*, fruits of *Bridelia retusa* in Manas sanctuary. *Terminalia belerica* at Jamduar and Flowers of *Salmalia malabarica* at Manas [13]. The above results indicate that Golden Langur consumed variety of plants. The number of food species listed varied greatly with forest type, duration of study period and method of foraging data collection. Some of the plants which have medicinal property are used as food as well as ethno medicine by the local community. The present study reveals that the rural tribal people are well versed with the nature and natural resources around them. These people in order to get rid of various problems like abortion, conception, menstrual problems etc., depend on plant products. Such types of plant extracts have also been reported to be used for abortifacient and reproductive related diseases from other part of the state also. The efficacy of the traditional medicine cannot be judged properly, although the ethnic tribal people use these plants for curing different type of reproductive and in general physical ailments [14-16]. Due importance should be provided for further research on these medicinal plants for their effectiveness, side effects and mode of action. Overlapping with the usage of these plants as food by Golden Langur with the practice of local tribes as medicines and food gives a general idea of bioactive properties of plants which can be further use to investigate the pharmacological properties of the plant species. A thorough and complete survey is to made for the availability of these plants. The common people must be made conscious about the usage of the plants by Golden Langur in their respective localities. The social forestry may bear an important share for plantation of different medicinal and fruit bearing plants like Amlaki, (*Emblica officinalis*), Jamu (*Syzygium cumini*) etc. which are the sources of different natural vitamins and minerals and are food sources of Golden Langur too. Moreover, the wise use of the food plant species of Golden Langur by the locals as medicines and vegetables can help to sustain the lives of Primates in the fragmented habitats. The relationships between plants, primates and humans observed in the present study indicate potential bioactive compounds to be examined in future pharmacological and phyto-chemical studies, especially those plants with

antiparasitic activity [17,18]. Both aspects could significantly contribute to improving the quality of life of local communities and to the sustainability of the fragmented forests, especially at the study site. The study gives a real time situation on field information that can be utilized for habitat assessment and management too.

### Acknowledgement

The authors are thankful to Assam Forest Department for permission to conduct research in Kakoijana Reserve forests of Assam, India. We are highly grateful to Bombay Natural History Society (BNHS), India for their help in identifying Plant species and A.V.C. College (Autonomous), Department of Zoology and Wildlife Biology, Tamil Nadu, India for their support. We thank Nature's Foster (NGO, based at Bongaigaon, Assam, India) for their moral support. We thank our field assistants for their help in the field.

### References

1. Altmann J (1974) Observational study of behavior: sampling method. Behaviour 49 (3/4): 227-267.
2. Ashokkumar M (2011) Population, Foraging, And Activity Pattern of Gaur. In: Bos gaurus H, et al. (Eds.), Mudumalai Tiger Reserve, Ph.D. Dissertation, Bharathidasan University. Tiruchirappalli, Tamilnadu, India.
3. Swapna N (2008) Assessing the feeding ecology of the Bengal Slow Loris (*Nycticebus bengalensis*) in Trishna wildlife sanctuary. Tripura. M.sc., thesis submitted to Manipal University.
4. Carrai V, Borgognini Tarli SM, Huffman MA, Bardi M (2002) Increase in tannin consumption by sifaka (*Propithecus verreauxi verreauxi*) females during the birth season: a case for self-medication in prosimians? Primates 44: 61-66.
5. Cousins D, Huffman MA (2002) Medicinal properties in the diet of gorillas: an ethno-pharmacological evaluation. Af rStudy Monogr 23(2): 65-89.
6. MacIntosh AJJ, Huffman MA (2010) Towards understanding the role of diet in host-parasite interactions in the case of Japanese macaques. In: Nakagawa F, et al. (Eds.), The Japanese Macaques. Springer, Tokyo, pp: 323-344.

7. Oats JF (1987) Food distribution and foraging behavior. In: Smuts BB, et al. (Eds.), Primate Societies. University of Chicago Press, Chicago.
8. Lambert JE (2011) Primate nutritional ecology. Feeding biology and diet at ecological and evolutionary scales. In: Campbell, (Ed.), Primates in Perspective. University of Oxford Press, Oxford, pp: 512-522.
9. Glander KE (1982) The impact of plant secondary compounds on primate feeding behavior. Am J Phys Anthropol 25(S3): 1-18.
10. Khajuria H (1956) A new Langur (Primates: Colobidae) from Goalpara District, Assam. Annual Magazine Natural History 9(98): 86-88.
11. Mills MGL (1992) A comparison of methods used to study food habits of large African Carnivores. In Wildlife 2001: Population, pp: 1112-1124.
12. Das R, Sinha H, Sahu HK, Choudhury K (2013) Golden Langur *Trachypithecus geei* (Khajuria, 1956) feeding on *Cryptocoryne retorspiralis* (Roxb.) Kunth (Family: Araceae): a rare feeding observation in Chirang Reserve Forest, Assam, India Journal of Threatened Taxa 5(15): 5013-5015.
13. Mukherjee RP, Saha SS (1974) The Golden Langurs (*Presbytis geei* Khajuria, 1956) of Assam. Primates 15(4): 327-340.
14. Boissya CL, Mazumdar R, Mazumdar AK (1981) Some medicinal plants from Darrang District of Assam (India). J Anthropos (West Germany) 76: 220-222.
15. Bentham G, Hooker JD (1983) Genera Plantarum, pp: 475.
16. Bhattacharya PC, Muzumder R, Sarmah GCD (1991) Rare medicinal plants of Assam. Ancient Science of life 10(4): 234-238.
17. Kumar A, Solanki GS (2004) A rare feeding observation on water lilies (*Nymphaea alba*) by the Capped Langur (*Trachypithecus pileatus*). Folia Primatologica 75(3): 157-159.
18. Sasidharan N (2004) Forest Trees of Kerala. Kerala Forest Research Institute, Peechi, Thrissur.

